App. No. 10/848,742
Office Action Dated December 23, 2005

REMARKS

Reconsideration is respectfully requested in view of the above amendments and following remarks. Applicants appreciate the courtesy shown by the Examiner in discussing this application with the Applicants' representative on February 27, 2006. The discussions of the interview are reflected in the comments below.

Claim 1 has been amended. The limitation concerning Ms of the magnetic layers is supported by canceled claim 3, and the limitation concerning the materials of the non-magnetic layer is supported for example by page 33, lines 17-25. Claims 3, 5, 12-17 and 61-63 are canceled without prejudice or disclaimer. Applicants respectfully submit that no new matter is added by the proposed revisions. Claims 1-2, 39, 41, 42, 45, 47, 48, 51, 59, 65, 66, 69, 71 and 72 are pending. Claim 59 has been withdrawn from consideration, but is suitable for reinstatement upon allowance of claim 1.

Claim Rejections - 35 U.S.C. § 102

Claims 1-3, 5, 12-14, 17, 39, 45, 51, 65, 66 and 69 are rejected under 35 U.S.C. 102(e) as being anticipated by Fukuzawa et al. (U.S. Patent App. No. 2005/0030676 A1). Applicants respectfully traverse this rejection.

Claim 1 requires the sum of the products Mmxdm for odd m to be substantially equal to the sum of the products Mmxdm for even m in the magnetic layers constituting the free magnetic layer, where the magnetic layers m are arranged at the position m (m=1,2,...) from the side of the intermediate layer as the magnetic layers m, and where the product Mmxdm is the product of the average saturation magnetization Mm of the magnetic layers m and the average layer thickness dm (see page 34, lines 11-18 for example). Under these conditions, the demagnetization field is suppressed by magnetostatic coupling of the magnetic fields leaking from the two layers, and this

suppression contributes to reduction of coercivity as observed in Sample 2 of Fig. 6 (see page 33, lines 12-16 for example). Further, claim 1 requires the non-magnetic layer to be made of Ta, Ti, Zr, Hf, V, Nb, Cr, Mo, W, Al, SiO_2, SiC, Si_3N_4, Al_2O_3, AlN, Cr_2O_3, Cr_2N, TiO, TiN, TiC HfO_2, HfN, HfC, Ta_2O_5, TaN, TaC, BN and B_4C (see page 33, lines 21-22 for example). By using these materials for the non-magnetic layer and by providing the non-magnetic layer in the range of 2.6 nm $\leq$ d $<$ 10 nm where d is the thickness of the non-magnetic layer, the magnetic domains are simplified, and a high MR can be obtained (see page 4, lines 20-22 and page 33, lines 19-25 for example).

The experimental work in the present specification supports the allowability of claim 1. Note that Sample 2 with the MR element configuration Ta(3)/Cu(500)Ta(3)/PtMn(30)/CoFe(3)/Ru(0.7)/CoFe(3)/Al_2O_3(1)/ NiFe(4)/Ta(3)/NiFe(4)/Ta(3) unexpectedly showed no increase of the coercivity with respect to the element width (see page 33, lines 12-13 for example). Further, when Ti, Zr, Hf, V, Nb, Cr, Mo, W, Al, SiO_2, SiC, Si_3N_4, Al_2O_3, AlN, Cr_2O_3, Cr_2N, TiO, TiN, TiC HfO_2, HfN, HfC, Ta_2O_5, TaN, TaC, BN and B_4C were examined as non–magnetic layers other than Ta, it was found that a similar effect as with Ta could be attained with non–magnetic metals, oxides, nitrides and with carbides (see page 33, lines 21-25).

Further, the thickness of the two NiFe layers sandwiching the Ta was examined for Sample 2. When samples were produced with different thicknesses of the two NiFe layers sandwiching the Ta in this range of film thickness, it was observed that the coercivity tended to increase compared to the samples with the same film thickness. The relation between the film thickness differences in the magnetic layers was further examined, with the following free magnetic layers

Sample a: NiFe(X)/Ta(3)/NiFe(Y)/Ta(3)/NiFe(Z)

Sample b: NiFe(X)/Ta(3)/CoFe(Y)/Ta(3)/NiFe(Z)

Sample c: NiFe(X)/Ta(3)/NiFe(Y)/Ta(3)/CoFe(Z)

wherein X, Y, and Z were varied over several values. As the result, in Sample a, under the condition that the thickness X+Y+Z was constant, a lower coercivity was attained when X+Z=Y, and substantially the lowest value was attained when further X=Z. In Sample b, under the condition that the thickness X+Y+Z was constant, when the saturation magnetization of the NiFe is Ms1 and the saturation magnetization of the CoFe is Ms2, a low coercivity was attained under the condition that Ms1×(X+Z)=Ms2×Y, and the lowest value was attained when X=Z. Furthermore, in Sample c, a low coercivity was attained when Ms1×X+Ms2×Z=Ms1×Y (see page 33, lines 26-37 and page 34, lines 1-10).

Thus, the advantages are enjoyed by the present invention when the sum of the products Mm×dm for odd m is substantially equal to the sum of the products Mm×dm for even m in the magnetic layers constituting the free magnetic layer, where the magnetic layers m are arranged at the position m (m=1,2,...) from the side of the intermediate layer as the magnetic layers m, and where the product Mmxdm is the product of the average saturation magnetization Mm of the magnetic layers m and the average layer thickness dm (see page 34, lines 11-18).

Fukuzawa fails to teach the limitation concerning Ms of the magnetic layer and the limitation concerning the materials of the non-magnetic layer of claim 1. In fact, Fukuzawa discloses 5nm Ta/5nm NiFeCr/1nm Au/1nm Cu/3nm CoFe/2.5nm Cu/ 2.5 nm CoFe/7nm IrMn/5nm Ta, wherein 5nm NiFeCr and 3nm CoFe is the free layer and Au/Cu is the non-magnetic layer (paragraph [526]). This structure corresponds to Sample 3 of

Working Example 1. As shown in Fig. 6, an unexpected lowering of coercivity is indicated by comparing Sample 3 and Sample 2. In view of these findings, Applicants respectfully submit that the present invention provides benefits that would have been unexpected to one of ordinary skill.

For at least the foregoing reasons, Applicants respectfully submit that claim 1 is patentable over Fukuzawa.

Claims 39, 45, 51, 65, 66 and 69 are patentable over Fukuzawa for at least the same reasons as claim 1.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

Claim Rejections - 35 U.S.C. § 103

Claim 71 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuzawa as applied above, and further in view of Sakakima et al. (J. Mag. Mag. Mat., 210, 2000, L20-L24). Applicants respectfully traverse this rejection.

Fukuzawa has been distinguished above. Claim 71 depends upon and further limits claim 1 discussed above as patentable. Claim 71 is patentable over Fukuzawa and Sakakima for at least the same reasons as claim 1. Furthermore, it would not be obvious that the cited references could reasonably be combined to arrive at the features of the present invention or any advantages enjoyed by the present invention.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

Claims 47 and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuzawa as applied above, and further in view of Redon et al. (U.S. Patent No. 6,381,107 B1). Applicants respectfully traverse this rejection.

Fukuzawa has been distinguished above. Claim 48 depends upon and further limits claim 47. Claim 47 depends upon and further limits claim 1 discussed above as patentable. Claim 47 and 48 are patentable over Fukuzawa and Redon for at least the same reasons as claim 1. Furthermore, it would not be obvious that the cited references could reasonably be combined to arrive at the features of the present invention or any advantages enjoyed by the present invention.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

Claims 1, 5, 12, 13, 15, 17, 39, 45 and 71 are rejected under 35 U.S.C. 103(a) as being unpatentable over Odagawa et al. (U.S. Patent App. No. 2002/0058158 A1) in view of Parkin (U.S. Patent No. 5,585,986). The rejection is rendered moot as claim 3, whose limitations are now present in claim 1, was not rejected. Applicants do not concede the correctness of the rejection.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

Claims 2, 14, 16, 51 and 61-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Odagawa et al. as applied above, and further in view of Fukuzawa et al. ('676 A1). The rejection is rendered moot as claim 3, whose limitations are now present in claim 1, was not rejected. Applicants do not concede the correctness of the rejection.

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Claims 47 and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Odagawa et al. as applied above, and further in view of Redon et al. ('107 B1). The rejection is rendered moot as claim 3, whose limitations are now present in claim 1, was not rejected. Applicants do not concede the correctness of the rejection.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

With the above amendments and remarks, Applicants believe that the pending claims are in a condition for allowance. Applicants respectfully request favorable reconsideration by the Examiner in the form of a Notice of Allowance. If any questions arise, the Examiner is invited to contact Applicants' representative at the number listed below.

Respectfully Submitted,

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